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X-ray CT-technology revealing the effects of denitrifying bacteria on porous limestone

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Paracoccus denitrificans has been used to study the effects of microbiologically induced nitrogen gas production and calcium carbonate precipitation within two porous limestones: Savonnières (France) and Tabaire (Spain). Both limestones are used as building materials and consist of a different pore network and therefore induce different fluid flow behavior. Primarily, the bacteria in suspension were flushed through the samples (i.e. colloid transport, e.g. Molnar et al., 2015) and counted with a flow cytometer to see if and how they got retained within the pore network. Additionally, the immersed limestone samples got stored at 36 °C and were imaged multiple times using X-ray Computed Tomography (X-ray CT) (Cnudde & Boone, 2013). Within a predefined time interval, they were scanned to see two reaction products: the evolution of the production and magnitude of nitrogen gas and microbiologically induced calcium carbonate precipitation. This technique made it possible to create a 3D grain and pore network model of the samples immersed with the bacteria. Not only did it show the different locations of nitrogen gas and newly deposited calcium carbonate, but also how this evolved over time and how this affected the grains and pore network. Due to this changing pore network, changes of the water flow within the samples are generated which influence their weathering behaviour. Furthermore, it also resulted in a better understanding about how limestone, with a completely different pore network, influences the activity of the bacteria and vice versa.